Fixation of fractures involving the mandible, maxilla, and skull

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Mandible fractures occur more frequently than maxilla fractures. More specific, hemi-mandibular fractures are more commonly encountered. In many cases, fracture follows grasping an object and setting back rapidly; however, these fractures can occur from kicks, falling over, or running into an immovable object. Pathologic fractures may be seen in progressive severe dental disease with chronic infection and osteolysis. On other occasions, tumors render the mandible fragile, predisposing it to fracture.

Facial asymmetry, excessive salivation, and localized swelling are commonly present. Radiographs provide a definitive diagnosis using multiple projections. For rostral fractures, intra-oral radiographs are indicated. Mandibular and maxillary fractures should always be considered open fractures. Fractures of the rostral mandible and maxilla are usually amenable to successful repair. This is attributable to: 1) an abundance of vascular supply and liberal soft tissue coverage; 2) the soft tissue attachments and bilaterally symmetrical mandibles provide excellent support for fractures; and 3) tension surfaces of the mandible and maxilla are on the oral side. Unilateral fractures often require minimal fixation because of the stability provided by the contralateral mandible. Unstable fractures or those resulting in malocclusion should be repaired; the simplest method of fixation usually satisfies the biomechanical requirements.

Rostral Mandible and Maxilla Fractures

Fractures of the rostral portion of the mandible, the maxilla, and the incisive bones can be repaired with 16 or 18 gauge wire. Simple fractures involving one to three incisors can be repaired in the standing, sedated horse with mental or infraorbital nerve blocks performed to provide regional anesthesia; local anesthesia can be used in very simple fractures. Alternatively, intra-oral wire fixation can be performed with horse under injectable anesthesia. Fractures involving the interdental space usually require general anesthesia. The mouth should be rinsed well to remove feed material, and the fracture site should be scrubbed with dilute betadine solution. If a wire is to be passed around the second or third premolars, stab incision sites are clipped and overlying skin aseptically prepared.

The fracture site should be thoroughly debrided, and food material, clotted blood, and bone fragments should be removed while avoiding disruption of permanent teeth. Completely detached or broken teeth should be removed; however, loose deciduous teeth should be left in the alveolar socket because they often survive better than anticipated and provide stability, structure, and positioning for erupting permanent teeth. If necessary, the loose teeth can be removed at a later stage or at the time of implant removal. In young horses, maturation of incisors will be normal if the germinal buds have not been damaged.

Fractures involving 4 or fewer incisors can be repaired with cerclage wire fixation techniques. As a rule of thumb, wires should engage a minimum of 2 teeth, as the teeth immediately adjacent to the fracture will not be stable. At least 2 loops should be used to secure a fracture fragment. Ideally, the wire loops should be overlapped to improve stabili-
zation. A 14-gauge needle (or 2-mm drill bit) can be used to guide the stainless steel wire through the interalveolar spaces. The wires should be tightened with pliers or needle drivers. When necessary, additional stabilization can be achieved by securing the corner incisor or incisors to an erupted canine tooth, fixed to the interdental space, or to the second premolar. Incorporating the second premolar into the fixation involves placement of a tension band wire from the incisors to the second premolar. A stab incision and drilling of a 2-mm hole between the second and third premolars are required for the wire to be pulled through the cheek, between the second and third premolars, and directed rostral to be laced between the incisors. The wires spanning the interdental space are twisted together to increase compression at the fracture site. After tightening, the ends of the wires should be bent flat and may be covered with a small amount of acrylic. Rostral fractures usually heal without complication in 4 to 6 weeks, provided that stabilization is adequate and permanent tooth buds are not involved. Wires can be removed with minimal sedation in the standing horse.

**Interdental Space Fractures**

Simple unilateral or simple bilateral interdental space fractures can be managed with intraoral tension band wires spanning between the incisors and the second premolar. Adjunctive methods of stabilizing simple types of fractures include: figure-8 wiring of the fracture fragments, acrylic intraoral splints, combination of pins and wires, or an external fixator. Long oblique fractures of the interdental space can be repaired with cortical bone screws placed in lag fashion along with intraoral tension band wiring. For severely comminuted fractures, compression fractures, complex bilateral fractures, or those with missing pieces of bone, an intraoral splint, an external fixator, or bone plates may be necessary to provide stability as a strut or buttress. Intraoral splints may be made from acrylic or malleable aluminum or brass rods and contoured to fit the buccal surface of the teeth. Splints are wired at intervals to the incisors and also between the second and third premolars. External fixators have the advantage of providing rigid stability without the need to directly invade the fracture site or further damage the soft tissue envelope. Positive profile pins provide superior bone purchase when using external fixators. As a rule of thumb, a minimum of 2 pins should engage the parent bone and the principal bone. Dynamic compression plates positioned along the lateral aspect of the mandible can be used; ensure that at least 3 screws are placed on each side of the fracture. Bony fragments without soft tissue attachments may be discarded; however, fragments in this location with minimal soft tissue coverage are likely to survive due to the generous vascular supply. Comminution is likely to lead to sequestrum formation and radiographs should be included on subsequent evaluation if sequestration is suspected due to persistent drainage. Fractures into the alveolus do not mandate that the tooth be removed. It is preferable to stabilize the teeth and remove them only when they are clearly devitalized on subsequent examination. Fractures involving the interdental space may require a longer healing period (approximately 8-10 weeks).

**Caudal Mandible Fractures**

Fractures involving the interdental space extending into the dental arcade can be difficult cases to manage. Commonly these cases are managed with either external fixators or dynamic compression plates. The above principals for soft tissue, tooth management and method of fixation apply to this type of fracture configuration.
Fractures involving the vertical ramus, the angle of the ramus, the coronoid process, or the temporomandibular joint are uncommon. Conservative management consisting of dietary modification and anti-inflammatory medication is utilized in most of these cases. Unstable ramus of the mandible fractures should be managed with a dynamic compression plate placed along the caudal margin of the bone. Careful preservation of the facial artery and vein, facial nerve, and parotid duct is imperative. Coronoid process fractures can be surgically removed if dental abnormalities begin to develop because of altered mastication. Mandibular condylectomy has been suggested as a possible treatment for management of fractured or luxated temporomandibular joints.

**Skull Fractures**

Depression fractures of the skull are commonly encountered fractures. Additional structures that may be injured include the eye, orbit, teeth, cranial nerves, and nasal passage. Endoscopic examination of the nasal passage and ocular and/or neurologic examinations may be warranted. Severe crushing injuries to the nasal passage may require a temporary tracheostomy to be performed. Multiple oblique radiographic views are often necessary to determine the extent of trauma; however, interpretation is often difficult because of superimposition. Repair is usually limited to those fragments that are displaced or unstable.

Surgical repair is often easier following resolution of the soft tissue swelling because it is easier to ascertain fracture reduction. General anesthesia and aseptic preparation are usually recommended for repair. Surgical approaches are not standardized and are dictated by the individual patient’s fracture configuration. Depression fractures can be elevated and wedged into place via 2.0 mm holes drilled into the depressed segment(s) of bone. A curved instrument is inserted through the drilled hole and the fragments are elevated until they interdigitate with the parent bone. Frequently, no other form of stabilization is required. If additional stabilization is required, 18 or 20 gauge wire or PDS suture material may be used to secure fragments into place as indicated. Wiring should be performed via small incisions and pre-drilled holes in order to maintain soft tissue attachments. Soft tissue attachments are essential for stabilization and maintenance of vascularity. Small avascular fragments should be discarded. Local wound therapy is imperative if an open wound is present.